

# Underground Issues Management Issues

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November 23, 2009

# Outline

- Construction cost risks
- ODH Risk
- R&D plan management
- Recommendations scorecard from last year's review
- Summary

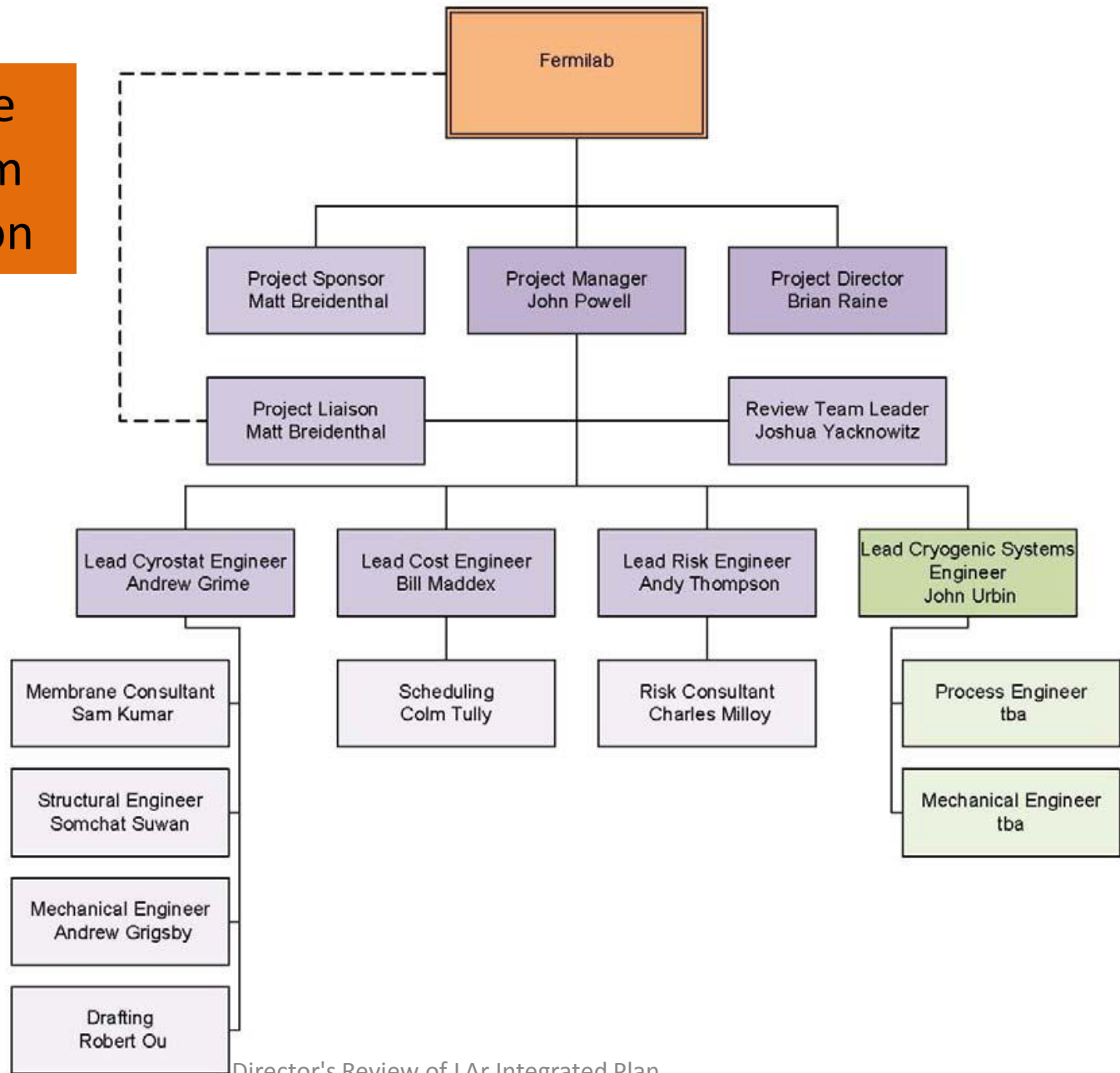
# Construction Cost Risks

- Two related issues
  - “Standard” risk associated with large science projects
    - unique and expensive
  - Underground construction at 4850 level
    - Travel time work site ~20 minutes (cage ride + walk)
    - Two shafts (1 for excavation contractors, 1 for all DUSEL experiments)
    - Yates Super cage size = 4.1m x 3.2m x ~10m
  - Underground construction at 300 level
    - Dedicated cavern for LAr20
    - Drive-in access
    - Similar to construction in above ground building

# Construction Cost Risk Mitigation - 1

- Cryostat and cryogenics plant conceptual design by Arup
  - Specialist in conceptual design of LNG, civil and underground facilities (not construction)
  - 10 years experience in membrane tanks for offshore LNG storage
  - 8 years experience in modular tanks for onshore and offshore LNG storage
  - Installation logistics for offshore and remote locations
  - Not associated with any vendors
  - Highly recommended by FNAL underground mining expert
  - Currently under contract with LBNL for 1) design of the DUSEL lab modules and 2) on-site evaluation of underground rock conditions

# Arup-Linde LAr20 Team Organization



# Arup Deliverables

- Design of membrane cryostat, modular cryostat and cryogenics plant at 300 level and 4850 level (4 vessel options, 2 cryo plant options)
- Layout drawings, process flow diagrams, FMEA, equipment list, outline execution plan, cost estimates ( $\pm 40\%$ ), level 2 construction schedule, recommendations
- Study period: 12 weeks
- Kickoff meeting at FNAL in early December

# Construction Cost Risk Mitigation - 2

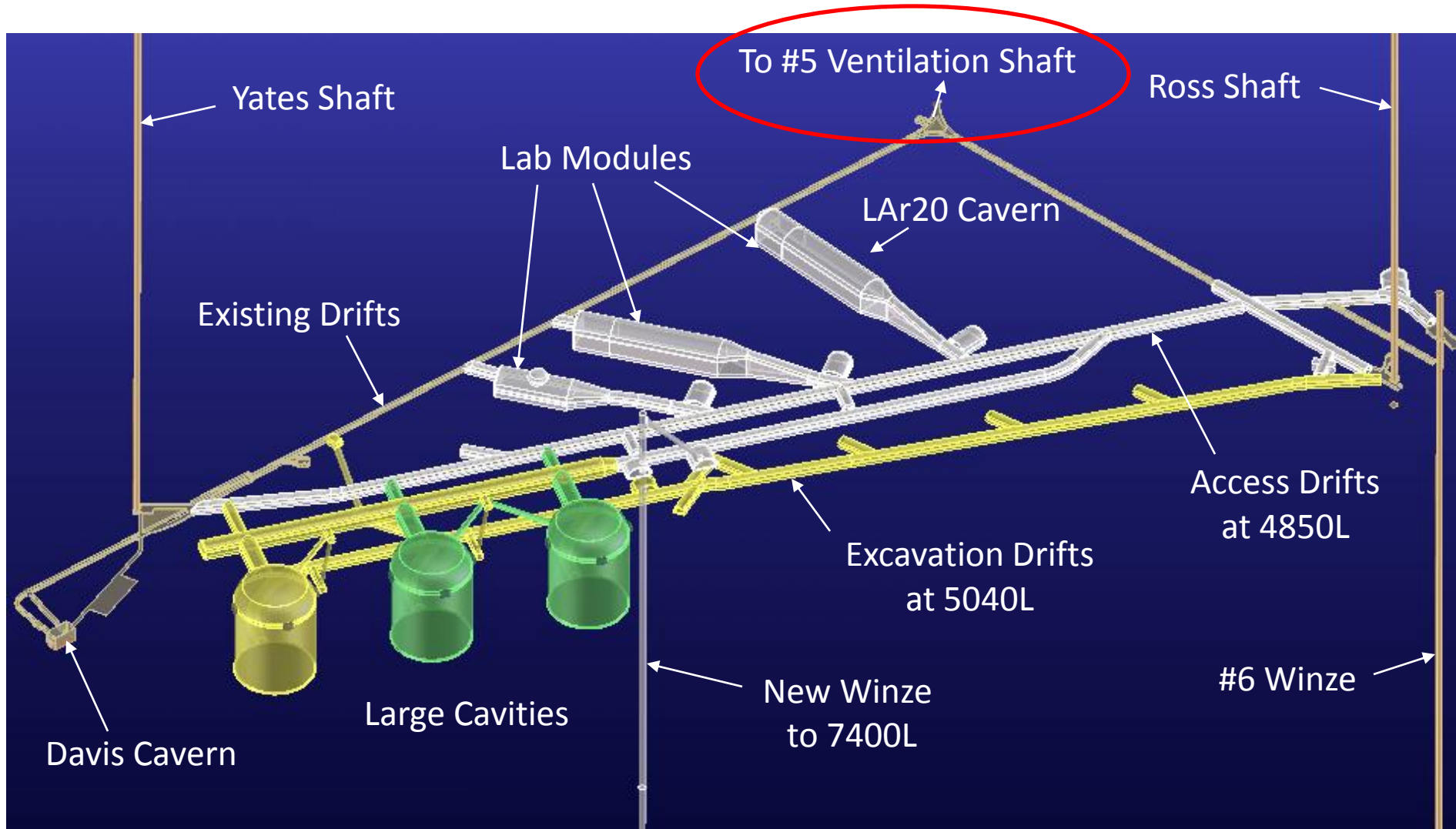
- Risk associated with conceptual design of TPC, electronics and DAQ by the LAr20 project team
  - Construct a TPC mockup (0.5 - 1 kton equivalent) with cryostat, insulation, TPC, cables etc
    - Use genuine components (\$)
    - No cryogenics plant (\$\$\$)
    - Simulate underground space constraints during construction
    - Track construction effort
  - Prototype could be converted into a functioning TPC with the addition of a cryogenics plant, electronics and DAQ
    - Not necessary to mitigate risk for Reference Design #1
    - Possible test facility for long drift (~5m) TPC module
  - Can potentially reuse components in LAr20

# ODH Risk Elements

- Huge inventory of cryogenics underground
- 4850 level will be a high occupancy campus
- Earthquake hazard similar to Fermilab
- Unplanned power outages are exceedingly rare
  - None exceeded 30 minutes during decades of mining
- Planning for re-liquefaction of all boil-off gas (Ar and N<sub>2</sub>)

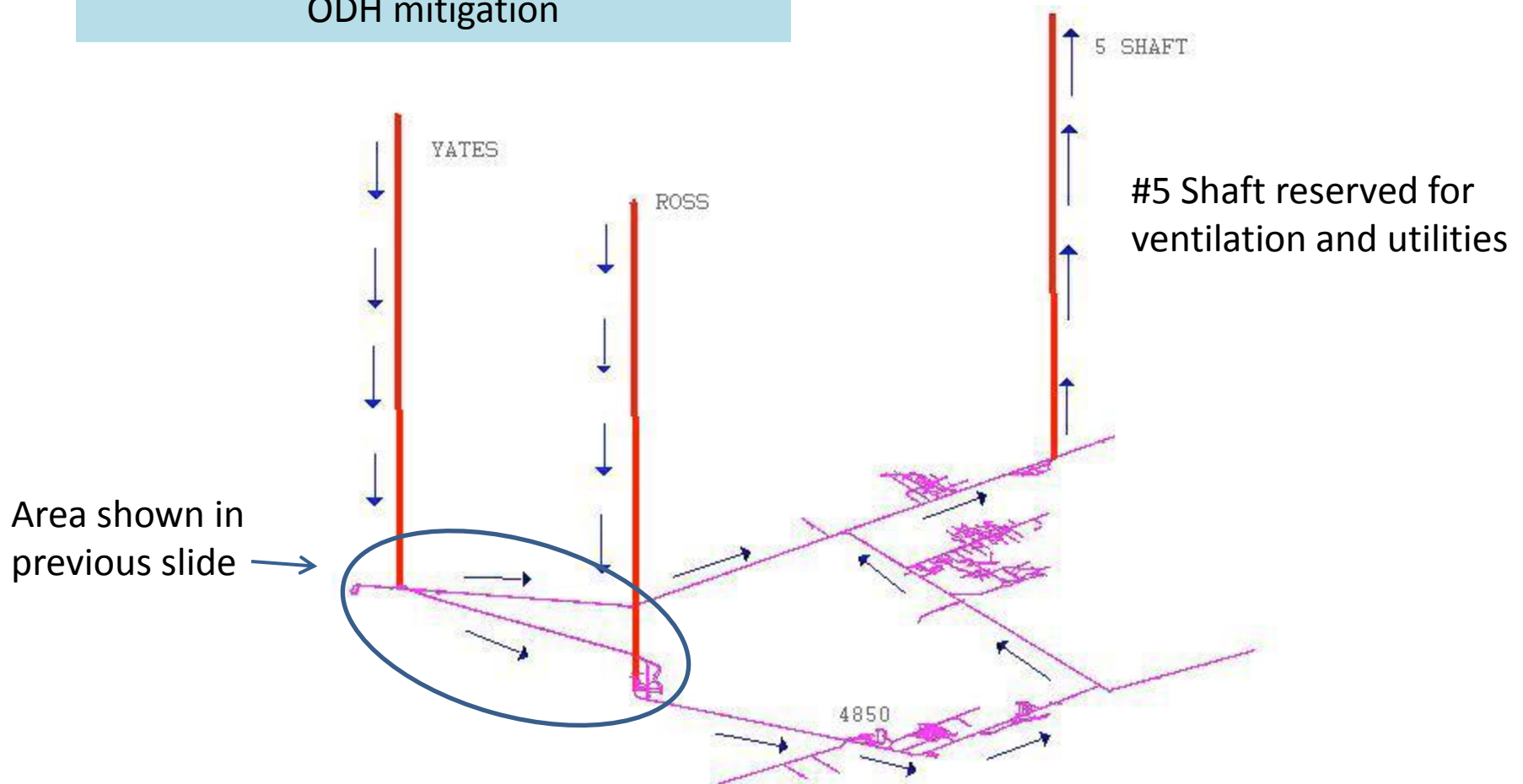


# 4850 Development Plan



# DUSEL Ventilation

Existing ventilation is conducive to LAr20  
ODH mitigation



# ODH Risk Elements

- Cavern will have a pit for full containment of the LAr inventory
- Probability of cryostat leak is negligible (for LNG)
  - “Risk Assessment of Membrane Type LNG Storage Tanks in Korea based on Fault Tree Analysis”, Korean J. Chem. Eng **22**(1) 1-8 (2005)
    - Probability of gross leak is once in 110,000 years

# ODH Risk Mitigation

- We have a verbal statement that DUSEL experiments must adhere to OSHA standards
- We have a verbal agreement with DUSEL that LAr20 will be design in conformance with the Fermilab cryogenic safety standard
  - The Fermilab standard was developed in-house
  - Is it applicable for a deep underground facility?
- We need to assure ourselves, DUSEL and the state of South Dakota that the cryogenic safety standard is applicable and that the LAr20 ODH mitigation plan conforms to the standard

# ODH Risk Mitigation Plan

- Conduct an external review of the Fermilab cryogenic safety standard and its use in LAr20
  - Currently searching for experts
    - UCSB Center for Risk Studies co-authored the GEOSTOCK risk assessment paper
    - Discussions with ES&H Section, head of the Cryogenic Safety Committee
    - Safety Engineering and Risk Analysis Division of ASME
    - Factory Mutual
  - Involve all stakeholders

# R&D Plan Management

KA15 = Generic Detector R&D

KA11 = Proton Research includes operations and project related R&D



R&D Activity	Status	Funding Source	Scale	Lead
Test stands	On going	KA15 R&D	~\$1M	Pordes
ArgoNeuT	Running	KA15 R&D, NSF	~\$1M	Soderberg
LAPD	Procurement	KA15 R&D, KA11 R&D	~\$1M	Plunkett, Rebel
MicroBooNE	CD-1 March	DOE Project, NSF	\$20M	James, Fleming
Membrane cryostat prototype	Proposed	LBNE/LAr20 R&D	<\$1M	
Installation/Integration prototype	Proposed	LBNE/LAr20 R&D	~\$5M	Baller
Electronics stress test	Proposed	LBNE/LAr20 R&D		Baller
HV Feedthrough test	Proposed	LBNE/LAr20 R&D	~ \$200k	Baller
Review FNAL cryo safety standard	Proposed	LBNE/LAr20 R&D	~\$20k	Baller
Calibration test	Proposed		~\$1M	

# R&D Plan Management

- Coordination of activities
  - Planning monthly meetings
  - LArSoft is coordinated by design
- WBS structure @L3: MicroBooNE = LAr20
  - Cost experience from MicroBooNE → LAr20
- LBNE project is 1 year old
  - LAr R&D is now being done within the context of LBNE-LAr20




# Scorecard from June 2008 Review

## Comments/Concerns

- 1) The civil engineering design for the underground enclosure at DUSEL and the LAr vessel design and modularity are closely related and should be studied as a whole. These studies may lead to modified designs with issues that should be explored in during the R&D phase. 
- 2) Construction of 10 KT modules each 15 M x 15 M x 50 M deep underground at DUSEL (4850 ft) as described requires welded assembly of the vessel from kit made up of thousands of plates sized to fit in the existing elevator. There will be important cost and schedule implications due to this constraint. This requires serious engineering study, and practical experience, etc. Alternative assembly techniques or modified methods of access to DUSEL may result in changes to the basic detector design. Assembly at depth of the entire detector represents a huge construction activity, all at depth. We were not presented with a plan for carrying out more general engineering studies of these issues. This seems to a necessary part of any program leading to 100 KT scale detector. 





# Comments/Concerns

- 3) Safety for such a large LAr vessel will be an important consideration if located at depth in DUSEL or Soudan, we did not hear a plan for engineering to be performed in this area. 
- 4) More refined cost scaling studies will be a necessary part of demonstrating feasibility of a 100 KT detector and should be part of the proposed program 
- 5) The team currently engaged in this work is capable but too small for the planned activities. To achieve the stated goals the workforce will have to be expanded considerably, especially in the area of engineering support. 

# Comments/Concerns

- 6) It seems the 5 KT detector at Soudan is driven by physics considerations while a smaller module located elsewhere might achieve all the engineering goals regardless of location. Once LAr5 becomes driven by physics its design may drift away from that optimal to demonstrate techniques for an eventual 100 KT detector at DUSEL.

# Recommendations

- 2) **The Laboratory/proponents need to examine the goals of MicroBooNE and understand clearly what it realistically will and will not contribute to preparations for an eventual 100 KT LAr detector. The goal should be to insure that the areas not covered by MicroBooNE are covered elsewhere in the planned program.** 
  
- 3) **While necessary, the proposed R&D plan is insufficient as a plan to prepare for an eventual 100 KT LAr detector. The program needs to be substantially enhanced with strong engineering support. These studies may lead to other conclusions about the next steps on the way to a 100 KT detector.** 
  - a. Create a plan and propose engineering resources to explore the cryogenics design of the LAr Vessel
  - b. Propose a plan and estimate engineering resources to explore civil engineering-LAr vessel design tradeoffs
  - c. Propose a plan for engineering resources to further explore safety and cost issues for a 100 KT detector.

# Summary

- Significant developments since last year
  - Birth of LBNE – a complex project
    - CD-1 Dec 2010 (LAr20 is an option)
  - LAr detector development moving on multiple fronts
    - Material Test Stand – world class results
    - ArgoNeuT collecting data
    - MicroBooNE ready for CD-1 in March
    - LAPD under construction
  - Need timely results from LAr R&D to support future decisions on LBNE